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CONDENSATION NUCLEI IN THE MIRNYY REGION

by

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FOREIGN TECHNOLOGY DIVISION

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*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

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CONDENSATION NUCLEI IN THE MIRNYY REGION

A. I. Voskresenskiy

The atmosphere of Antarctica is highly transparent. High values of solar radiation and an increased range of visibility, for example, are a natural consequence of this characteristic. As we know, the atmosphere's transparency depends on the concentration of atmospheric aerosols, i.e., solid or liquid particles dispersed in the free atmosphere. At present, the study of atmospheric aerosols is receiving a great deal of attention both in the Soviet Union and abroad. Considerable attention is being given to the physicochemical and quantitative composition of atmospheric condensation nuclei, which are very small particles with sizes from $5 \cdot 10^{-7}$ to $5 \cdot 10^{-7}$ cm.

I published my initial extremely limited data about the number of condensation nuclei in the Mirnyy region in 1962 based on the findings of twelve series of measurements [2]. But because the site where the observations were made was not sufficiently representative of the observatory region (the observations were made on the Komsomol'k stoney mud volcano), the data presented were only approximate and characteristic of the sections with outcrops of bedrock.

More long-term observations of condensation nuclei were made from February through November 1965 in the vicinity of the weather station. The observations were made with Shol'ts nuclei counters (small model) manufactured by the main geophysical observatory [4]. The counter was designed using the

principle of cooling humidified air during its adiabatic expansion. The supersaturation (200-300%) created in the counter chamber in this case causes water vapor to condense on the nuclei, which are precipitated on the counter window in the form of drops. Of course, the supersaturation created in the instrument does not occur under natural conditions; thus, the counter readings are overestimated compared to the actual number of nuclei which participate in cloud formation. This integrated measuring procedure also makes it possible to estimate the aerosol component in order to solve some other problems.

The procedure for collecting the air samples for making the observations was modified somewhat; it is most like the procedure for collecting air samples during aircraft observations [1]. Considering the constancy of the high wind velocities in the vicinity of the Mirnyy observatory, an air intake was made based on the wind vane of the M-47 anemometer, from which the air was fed into the weather station room through a Durite air hose. The presence of the wind vane mounted above the roof of the weather station made it possible to direct the intake toward the wind when its velocity was greater than 3 m/s. The total length of the air line did not exceed 2 m. The air line's airtightness was regularly checked. When the wind velocity was less than 3 m/s or during precipitation, samples were obtained by injection. The total number of these observations did not exceed 10%.

According to the research of I. I. Gayvoronskiy [3], the differences in the air collection methods cause the measurement results to differ by an average of 20%. Therefore, forty series of comparative observations were made using the two sampling methods in question. It turned out that the injection method underestimates the value of the condensation nuclei by an average of 10% compared to the value obtained by the suction method, with the maximum difference reaching 46%.

The observations were usually made without using films to keep the chamber from fogging up when at least 4 cm^3 of air was introduced into it. The nuclei were counted on counter Z_2, while the observations were processed using the formula

$$N=B_1\frac{n}{V_2},$$

where B_1 is considered to be equal to 91; n is the number of nuclei falling on the counter Z_2; V_2 is the volume of the introduced sample.

During the period from February through November 1965, 442 series of observations were made; each of them consists of 3-5 measurements.

It should be noted that the wind conditions in the Mirnyy region which, as we know, greatly affect the nucleus concentration, have a number of peculiarities. They include the high frequency of the south-eastern and south-south-eastern (effluent) wind from the deep regions of Antarctica, where the underlying surface is virtually free from nucleus-forming characteristics. The eastern wind direction which is so predominant comes from with the encroachment of relatively warm sea air. The frequency of other directions during the year is low.

The above characteristics of the air masses which reach the Mirnyy region make it impossible to calculate the mean values of the condensation nuclei, since they depend on the ratio of the number of measurements made for the predominating wind directions. Therefore, the mean monthly values of the condensation nuclei were computed separately for the effluent south-eastern and south-south-eastern and cyclonic eastern winds. Table 1 gives the mean and extreme values of the concentration of condensation nuclei in the ground air layer during an effluent wind.

Table 1. Mean monthly and extreme values of atmospheric condensation nuclei during effluent wind (cm^{-3}).

	II	III	IV	V	VI	VII	VIII	IX	X	(1) Весь период
(2) Среднее	152	91	—	85	27	27	20	55	93	58
(3) Максимальное	260	164	—	127	73	73	55	127	182	260
(4) Минимальное	137	36	—	55	0	0	0	18	18	0
(5) Число наблюдений	25	19	—	19	107	48	42	23	23	306

KEY: (1) Entire period. (2) Mean. (3) Maximum.
(4) Minimum. (5) Number of observations.

The extremely low values of both the mean monthly and extreme concentrations of atmospheric condensation nuclei throughout the observation period should be pointed out. Condensation nuclei were not detected at all in certain air samples taken in June-July. All the condensation nuclei fell on the counter window during the first expansion of the counter chamber during the winter observations with an effluent wind. No nuclei were observed to have participated during the subsequent three-four expansions of the chamber. The mean value of the condensation nuclei for the entire observation period (58 cm^{-3}) is the lowest compared to other areas of the Earth.

When analyzing the mean monthly values of the nuclei, we can see a seasonal variation characterized by a decrease in the number of nuclei from fall to winter and a certain increase in the spring. Thus, the maximum mean monthly concentration of nuclei, 152 cm^{-3}, was observed in February, when the water area of the Davis Sea near the observatory was free of ice. This period also has a clearly expressed diurnal variation of the wind, consisting of a decrease in the effluent wind velocity and its withdrawal toward the northern rhumb lines during the daytime.

Table 2. Dependence of number of condensation nuclei on wind direction based on data of measurements on 2 February 1965.

	8 ч (1) 40 мин (2)	9 ч (1) 40 мин (2)	10 ч (1) 20 мин (2)	11 ч (1) 00 мин (2)	11 ч (1) 45 мин (2)	12 ч (1) 15 мин (2)	14 ч (1) 30 мин (2)	15 ч (1) 00 мин (2)	16 ч (1) 00 мин (2)
(3) Направление ветра	(6) ЮЮВ	(6) ЮЮВ	(6) ЮЮВ	(6) ЮЮВ	(7) ЮВ	(7) ЮВ	(8) ВСВ	(8) ВСВ	(7) ЮВ
(4) Скорость ветра (м/сек)	11,0	8,5	7,0	6,5	5,5	4,5	2,0	2,0	8,0
(5) Число ядер ($см^{-3}$)	91	73	81	55	91	73	273	291	137

KEY: (1) Hours. (2) Minutes. (3) Wind direction. (4) Wind velocity (m/s). (5) Number of nuclei (cm^{-3}). (6) South-south-east. (7) Southeast. (8) East-south-east.

As the Davis Sea freezes and the diurnal variation of the wind ceases, the mean monthly values of the number of nuclei decrease, reaching the maximum (20 cm^{-3}) in August. As the diurnal variation of the wind appears in September, and especially in October, the number of nuclei decreases again,

obviously because of the influx of sea air saturated with nuclei when the wind direction changes. This is confirmed by the data in Table 2, which gives the mean velocities and wind direction for the condensation nuclei measurement periods.

Table 3. Diurnal variation of number of condensation nuclei during effluent wind on 2 June 1965.

	8 ч (1) 40 мин (2)	9 ч (1) 40 мин (2)	10 ч (1) 20 мин (2)	11 ч (1) 00 мин (2)	11 ч (1) 45 мин (2)	12 ч (1) 15 мин (2)	15 ч (1) 00 мин (2)
(3) Направление ветра	(6) ЮЮВ	(6) ЮЮВ	(6) ЮЮВ	(6) ЮЮВ	(6) ЮЮВ	(6) ЮЮВ	(6) ЮЮВ
(4) Скорость ветра (*м/сек*) . . .	10	10	11	12	10	10	9
(5) Число ядер ($см^{-3}$)	31	37	12	30	18	31	24

(continued)

	15 ч (1) 45 мин (2)	16 ч (1) 00 мин (2)	17 ч (1) 15 мин (2)	18 ч (1) 00 мин (2)	18 ч (1) 40 мин (2)	21 ч (1) 10 мин (2)	21 ч (1) 30 мин (2)
(3) Направление ветра	(6) ЮЮВ	(6) ЮЮВ	(6) ЮЮВ	(6) ЮЮВ	(6) ЮЮВ	(6) ЮЮВ	(6) ЮЮВ
(4) Скорость ветра (*м/сек*) . . .	11	10	11	10	9	11	10
(5) Число ядер ($см^{-3}$)	12	24	31	12	24	18	31

KEY: (1) Hours. (2) Minutes. (3) Wind direction. (4) Wind velocity (m/s). (5) Number of nuclei (cm^{-3}). (6) South-south-east.

It is evident from Table 2 that the number of condensation nuclei not only increases significantly when the wind moves off in the east-north-eastern direction, but that it also continues to remain high during a certain period of time when the direction changes to south-eastern. In the springtime, when the water area of the Mirnyy roadstead is covered with shore ice, this contrast in the diurnal variation of the condensation nuclei is not as clearly pronounced. In the wintertime, when diurnal variation of the wind is virtually absent, the condensation nuclei content remains fixed during a 24-hour period (Table 3). The absence of a diurnal variation in the distribution of condensation nuclei is entirely natural, since the snow cover of Antarctica does not have nucleus-forming characteristics. The presence of

nuclei during the effluent wind is obviously connected with their precipitation by gravity from higher layers of the atmosphere. For this reason, we can assume that an inversion distribution of condensation nuclei is present in Antarctica.

The data in Tables 1-3 indicate the large role played by the sea air masses in transporting condensation nuclei to the continent of Antarctica. Here it is appropriate to recall A. Mrkos's detection of dust particles from South American and Australian flowering vegetation transported by air flows to the Vostok station more than 6000 km away from these continents [5].

Table 4. Mean monthly and extreme values of atmospheric condensation nuclei in the presence of an eastern wind (cm^{-3}).

	II	III	IV	V	VI	VII	VIII	IX	X	(1) Весь период
(2) Среднее	314	281	266	311	—	173	266	198	—	258
(3) Максимальное	561	396	456	495	—	411	371	404	—	561
(4) Минимальное	31	18	22	12	—	12	28	18	—	12
(5) Число наблюдений . . .	20	26	15	18	--	48	13	13	—	153

KEY: (1) Entire period. (2) Mean. (3) Maximum. (4) Minimum. (5) Number of observations.

A quantitative estimate of the effect of sea air flows on the concentration of condensation nuclei is made in Table 4, which shows the mean monthly and extreme values of the condensation nuclei in the presence of an easterly wind. It is evident from the table that when the sea wind encroaches, the mean concentration of condensation nuclei in the vicinity of the Mirnyy observatory increases four-fold. Here the mean monthly values approach those of the condensation nuclei above a sea area. It should be noted that most of the observations were made during a snowfall, when the nucleus washout effect is great.

As one would expect, no seasonal variation in the mean and extreme values is observed. However, more careful analysis revealed that the air masses which enter the Mirnyy region with Kerguelen wind cyclones are generally more

highly saturated with nuclei than the air masses from cyclones of the Antarctic front, for example. When Kerguelen cyclones are present, the air contains around 350-400 nuclei per cm^3 of air, and when Antarctic cyclones are present - 150-180. This can be explained by the fact that Kerguelen cyclones move into the Mirnyy region above the water surface directly from the site of their origination, whereas the cyclones of the Antarctic front travel a longer path, during which a large number of the nuclei are used in cloud-forming processes and are washed away by precipitation.

Although sea air masses are considered to be the main source of condensation nuclei in Antarctica, one must also consider the role of the rock masses that are not covered with snow almost all year round. The limited observations of the condensation nuclei made on the Komsomol'sk mud volcano in 1962 [2] indicate that even small outcrops of bedrock on the bottom surface can cause a large number of nuclei to enter the atmosphere; this amount is obviously greater than the number of nuclei coming from sea air. However, because of the small area of these rock masses, one can consider their role in the overall condensation nucleus balance to be local; this is all the more true because the presence of an intense ground inversion prevents them from being transferred into the upper layers of the atmosphere.

The following conclusions can be drawn from the analysis of the above information:

1. The number of condensation nuclei near the coast of Antarctica is extremely low and is closely tied to the wind direction. In the presence of an effluent wind, the mean concentration of atmospheric condensation nuclei in the ground layer is around 60 cm^{-3}, with a maximum value of 410 cm^{-3}. No nuclei at all were detected in some samples. When the sea wind encroaches on the shore, the mean number of condensation nuclei increases four-fold, being 258 cm^{-3}, with a maximum value of 561 cm^{-3}. The encroachment of Kerguelen wind cyclones is accompanied by a larger concentration of nuclei than during cyclones which move along the Antarctic front; this is because of the trajectories of movement of these cyclones.

2. A diurnal variation of the number of condensation nuclei is only observed during hot weather, when the wind direction shifts from the southern quadrant to the north-eastern one. The amplitude of the diurnal variations in the number of condensation nuclei reaches 200 cm^{-3}. There is no diurnal variation of the distribution of condensation nuclei in the wintertime in the presence of an effluent wind and any time during a cyclone wind. No connections were observed between the wind velocity and the distribution of condensation nuclei in the ground layer.

3. The ocean surface is the main source of atmospheric condensation nuclei in the Mirnyy region. Bedrock which protrudes onto the bottom surface causes a local increase in the number of nuclei; however, they obviously play a small part in the overall balance.

REFERENCES

1. Александров Н. И., Петренчук О. П. Методика измерений ядер конденсации в свободной атмосфере при самолетных зондированиях. Тр. Глав. геофиз. обсерватории, вып. 93. Л., Гидрометеоиздат, 1959.
2. Воскресенский А. И. Результаты метеорологических наблюдений первой воздушной экспедиции в Антарктиду. Тр. Сов. антаркт. эксп., т. 37. М.—Л., «Транспорт», 1964.
3. Гайворонский И. И. О ядрах конденсации в свободной атмосфере. Тр. Центр. аэрол. обсерватории, вып. 4. М.—Л., Гидрометеоиздат, 1949.
4. Грабовский Р. И. Атмосферные ядра конденсации. Л., Гидрометеоиздат, 1956.
5. Мркос А. Определение осадков космической пыли на поверхности ледникового щита Восточной Антарктиды. Информ. бюлл. Сов. антаркт. эксп., 1962, № 32.

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